Euclid, i. 4, holds generally, while we need something more than practical experiment to prove, say, that vertically opposite angles are equal, or that the three angles of any triangle are always together equal to two right angles. The need for proofs that are generally true may be brought out very clearly in such a matter as the consideration of the best practical methods for measuring plane surfaces, or some other similar work. In any case, let us bring home to the learner the need for more general proofs, and the nature of the method adopted for obtaining them; while, all through our geometrical work, let us keep in mind how refreshing it is to be allowed to see and appreciate the bearing of theory on practice, — the practical utility of the results of our theoretical work. Once again, what better means can we have for exercising pupils in mixed inductive and deductive reasoning than political economy? We may begin with a story from Miss Martineau's collection, — or, to be more precise, we may take 'The shipwrecked sailors,' from Mrs. Fawcett's 'Tales in political economy,' and work up to the question as to whether luxurious expenditure and waste are good for trade, or to the great problem of demand and supply, and the price of commodities, — making deductions from the principles at which we arrive, and testing them by comparison with the results of practical experience.

I will conclude by reminding you, that, for pure induction, you will generally have to rely on the physical sciences, — of which botany, energetics (if I may use the word), and chemistry will be the best for school purposes; while, for deduction, the whole field of mathematics lies before you. I may add that you will find an excellent model lesson in induction on the 'pile-driving machine' in Professor Payne's 'Lectures on education.' In mathematics, perhaps the best and simplest example of induction suitable to beginners is the well-known 'binomial theorem' for positive integral indices. H. COURTHOPE BOWEN.

MODERN BIOLOGY AS A BRANCH OF EDUCATION.

A GLANCE at our higher educational institutions to-day shows a tendency toward an increase in the importance of biological science. Everywhere biology is being separated as a distinct department, and at least one school is founded for the express purpose of pursuing this study. An increasing stress is being placed upon this science as a part of a liberal education, and its number of students is growing rapidly. We wish, in a few words, to show why this is so, and to give the grounds upon which biology is every year demanding more recognition.

Biology is sometimes called a *new* science. This is not because the subject-matter treated of is new, nor because living nature is a new subject for study, but rather because the method of study has so changed in the last twenty-five years that the study of life appears under an entirely new aspect. As material for a descriptive science, animals and plants have been studied for centuries, but biology as a dynamical science is of comparatively recent growth. Modern biology is neither zoölogy nor botany, though it of course includes the study of both animals and plants. The terms 'zoölogy' and 'botany' usually convey to the mind the idea of long names and tedious descriptions, with an overwhelming abundance of uninteresting details, and the student well asks what is their value to him. If biology offered to its students to-day no more than a description of animals and plants. it would be well questioned whether it should in justice demand any greater attention than has been allotted to zoölogy and botany for fifty years past. But scientific teachers are beginning to see that the learning of names and descriptions should bear about the same relation to biology that the learning of dates bears to history. Some dates must be learned in studying history, and some names and descriptions must be learned in studying biology; but the former does not constitute history, nor the latter biology. The rapid extension of observation on vital phenomena, and the more careful thought thereon, have been teaching scientists to comprise large groups of facts under general forms, and thus to deduce general laws regulating life. It is the study of these principles which is coming more and more to constitute the science of biology. The enormous multiplication of species is making zoölogy and botany unwieldy subjects to be treated in any general way. Classifications have, by reason of recent discoveries, grown so intricate and complicated that they can no longer be taught to the general student with any degree of satisfaction. But this very increase in discovery is adding to science new laws, is rendering intelligible the older ones, so that the material for the study of biology, as separate from zoölogy and botany, is becoming more abundant. Biology is thus rapidly freeing itself from the dry bones of detailed classification, and becoming of more and more interest and significance to the general student. Biology is growing to be more the study of life-principles as illustrated by animals and plants; is becoming, therefore, more a study of life, and not so much as it has been a study of living things.

It is biology with some such scope as indicated above, that is now claiming to be recognized as a necessary part of a liberal education. Education

has three primary objects : 1°, it should give mental training ; 2°, it should give a certain amount of practical knowledge ; 3°, it should place the student in such contact with philosophical thought that he may be able to understand the trend of thought at the present time. The new science of dynamical biology claims attention as assisting in the accomplishment of all three of these objects.

The value of biology as a means of mental discipline is chiefly in exercising the powers of observation. No course in this study is in any way complete without an accompanying course in laboratory work, though the amount of such work may be sometimes very small. There is nothing better adapted to teach the student to use his eyes accurately than a course in laboratory work upon living things, including microscopic study, dissection, and analysis. The value of this sort of education is, indeed, too plain to require more than a notice.

There is undoubtedly a growing demand in this country that studies should have a practical value ; and for any new study to force its way into wide acceptance, it must be able to show that it has some direct utility. Now, biology is by no means a 'bread-and-butter' study, unless, perchance, it be to those who aim to teach it. But it does give the student knowledge in those directions which Spencer calls the essentials of education, and which are too often neglected. It teaches him to be a good animal. Aside from its value as a preliminary medical training, biology gives an education which every one needs. There is hardly a discovery of the century which bids fair to produce more influence upon the human race than the germ theory of disease. This discovery is rapidly modifying methods of dealing with contagious diseases ; and it is an injustice to the student to send him into the world without a knowledge of these general facts, the significance of sanitary precautions, and the methods of avoiding disease. But aside from such facts, it is hardly possible to overestimate the value to every one of a study of the laws of life. The student learns that he, too, is an animal, and under the influence of the same laws which he finds elsewhere, and comes slowly to realize the meaning of many of these laws with a vividness which can be produced in no other way. He learns of the effect of surroundings upon the growth of living things, and that animals are largely what circumstances make them. He gains a strong impression of the lasting effects of habits, sees that nothing is too small to be without its influence. He is brought face to face with the degrading effects of parasitism in all its forms ; sees that inactivity is universally followed by degradation, and that only active animals can rise in nature ; learns that luxury is always the precursor of degradation, while adversity, if it be not so great as to destroy, is sure to exalt the animals under its influence. All of these factors, together with the physiological laws which he must obey, and hundreds of others of smaller import, are or should be forced upon a student who has taken a good course in biology ; and these facts, though not teaching men to earn a living, do teach them to make better use of their lives.

But, after all, the chief reason why biology is obtaining a greater recognition as a necessary branch of education, is none of these. but rather because of its relations to philosophical thought. Modern biology represents to us a final step of the belief in the universality of law. A comprehension of its import is therefore necessary to one who wishes to keep abreast of modern thought. From the time when the curiosity of early man was aroused concerning nature around him, he has been constantly asking for causes. At first the only sort of causality of which he had any conception was that of personality, and he therefore conceived that behind every phenomenon of nature there was a personality. The explanation of causes was thus polytheism. Slowly and irregularly there arose from this belief the nobler conception of monotheism. But all through the past centuries the God of monotheism was regarded as forming no part of nature proper, but as holding aloof from it, and interfering now and then to perform miracles. Indeed, even to-day we find not a few who still retain this conception, and scarcely see any room for God except to explain mysteries. But these mysteries have been disappearing. Little by little did more extended observations show that nature acts with uniformity, and there thus arose, vaguely at first but more clearly afterwards, the idea of natural law. Since the time of Newton's discovery of the first grand law of nature, there has been inaugurated a new method of research. Science, as we now understand the term, has arisen, and has been trying to reduce the varied phenomena of nature to an order, to discover the laws regulating them, and to investigate the former mysteries of nature, and explain them by the simple application of discovered law. One after another have the various realms of nature been studied, and one after another have they been comprehended under the universal reign of law. Nature's mysteries have been constantly uncovered and rendered intelligible. The thunder is no longer a bolt thrown by an angry deity, nor is the north wind the breath of an avenging god ; but each falls in with the general order of nature, and is explained by the

action of known laws and forces. Until within very recent times, however, it has not been imagined that the phenomena of life could be brought under the same laws which regulate the inorganic world. Life seems so different from all that is not living that it has been regarded as standing by itself. It is, withal, so mysterious that it has at all times been regarded as a direct instance of almighty power, and living things have been looked upon as miracles concerning which it was almost sacrilege to question.

Modern dynamical biology owes its existence to the attempt to apply to the organic world the same course of investigation which has been successful elsewhere; nay, indeed, to apply to life the same chemical and physical laws which govern the inorganic world. The first great step was taken in this direction by Darwin when he tried to show that species were not to be considered as special creations, but as having had a natural origin. Zoölogy and botany, as they had been studied before, were simply statical sciences, merely studying and classifying facts as they were found. Modern biology is a dynamical science, in that it attempts to explain the facts of life. All vital phenomena have been attacked with this purpose in view, and biologists are now strenuously trying to come to some explanation of the fundamental fact of life itself by the application of chemical and physical laws.

It is plain enough that such study and such conclusions are of great significance to the thoughts and beliefs of every one. It is not strange that these conclusions, removing as they do so many miracles from nature, should be regarded by many as conflicting with all theistic belief, for we are all inclined to think a fact is understood when it is comprised under any law. But it is equally evident that more careful thought shows that, even accepting these conclusions of biology, we are by no means able to say we have fathomed life, for we do not understand the reason for the existence of any single chemical or physical law. But whatever be the conclusion which may be reached as to the ability of biologists to explain life-principles, or as to the significance of the explanation when reached, it is certainly a necessity for any one who wishes to comprehend the thought of the times to get acquainted more or less intimately with these attempts of the *new* science. The students who go out from our higher schools are to take a stand among the foremost thinkers. Indeed, they are, it is hoped, to advance the thought of the world. Whether they be theologians, philosophers, scientists, or teachers, it is necessary for them to realize the meaning of the application of dynamics to life: they should understand the positions held by advanced biologists, and know at least the sort of arguments used to support these positions. In this fact, then, lies the essential reason for the growing importance of this study. As a branch for special study, biology has its own fascination and defence. But as fast as it becomes freed from the burden of detail, and becomes a study of life-principles, just so fast will it become recognized as a necessary part of the education of the general student

H. W. CONN.

THE FRENCH LYCÉE.

WHILE much of the educational inspiration of the day is drawn from Germany, it must be borne in mind that France is actively engaged in thinking out the great problems which are of common interest to all nations. We hear much of the 'gymnasium' and 'realschule,' but not so much of the 'lycée.' This word should call to our minds as definite and accurate an idea as the word 'gymnasium' does. The material for such an idea is contained in a short account of the curriculum of a French lycée recently published by Mr. W. H. Fraser of Upper Canada college.

The word 'lycée' itself, in its present application to the secondary colleges of France, dates back to Napoleon Bonaparte, and was given by him to them when he re-organized the university system. The name was afterwards changed to 'collége royal' at the restoration and under Louis Phillippe, but was changed again to lycée in 1848. 'Lycée' is the French form of λύκειον, the gymnasium near Athens, where Aristotle assembled the members of his school of philosophy. By extension it was applied to certain schools in Paris devoted to science and literature. Almost every considerable city and town in France has now its lycée, whilst in Paris there are several of them, for example, Lycée Henri IV., Louis-le-Grand, St. Louis, and others, — enormous establishments affording accommodation to many hundreds of students, both *internes* and *externes*, as the students in residence and the outsiders are respectively called. Until recently, only boys enjoyed the privileges of these colleges, but now provision has been made in several places, including Paris, for the education of girls also. Their colleges are entirely distinct, and the programme of those for girls is, in the main, a modified form of that prepared for their brothers.

The whole course of the lycée should be completed, and generally is completed, by the pupil before he has reached his twenty-first year. It may be finished, however, by the eighteenth year. This is not astonishing, when we reflect that